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King, Jr. et al.

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(54) **INSULATION DISPLACEMENT WIRE CONNECTORS**

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(51) **Int. Cl.**

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H01R 11/20	(2006.01)
H01R 4/24	(2006.01)
H01R 4/70	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 11/20*** (2013.01); ***H01R 4/2412*** (2013.01); ***H01R 4/2433*** (2013.01); *H01R 4/70* (2013.01)

(58) **Field of Classification Search**

CPC .. H01R 11/20; H01R 4/2416; H01R 4/2433; H01R 4/2445; H01R 4/2454; H01R 4/2466; H01R 4/70; H01R 4/2404; H01R 4/4818; H01R 12/616; H01R 13/567; H01R 24/25; H01R 24/28

USPC 439/694, 391, 395, 407, 409, 426, 439, 439/440, 443

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,435,747	A *	7/1995	Franckx	H01R 4/2433 439/409
5,498,172	A *	3/1996	Noda	H01R 12/616 439/404
7,918,684	B2 *	4/2011	Lu	H01R 4/2433 439/395
2007/0066123	A1 *	3/2007	Arlitt	H01R 4/24 439/409
2008/0081507	A1 *	4/2008	Mahajan	H01R 4/2404 439/410
2010/0029129	A1 *	2/2010	Cox	H01R 4/2433 439/405
2010/0068917	A1 *	3/2010	Dennes	H01R 4/2433 439/409

* cited by examiner

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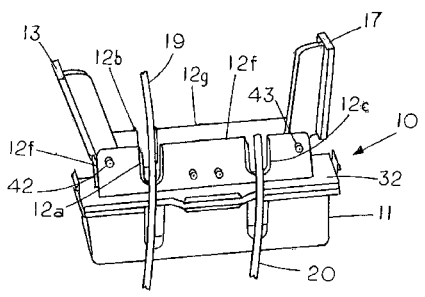
(57) **ABSTRACT**

A field friendly wire connector for on-the-go connecting insulation coated electrical wires to each other without having to remove the wire insulation coating from either of the wires and without having to cut the wires with the wire connector including a flexible electrical conductor mounted in a connector base and a pair of slotted pivot arms sandwiching the flexible electrical conductor therein as the slotted pivot arms push the electrical wires into electrical contact with the electrical connector and a dual mode housing that forms a hand grip when attached to a first side of the connector base to provide a hand grip or support to the wire connector during formation of electrical connections and when the dual mode housing is attached to an opposite side of the connector base the dual mode housing forms a protective covering over the electrical connections.

20 Claims, 5 Drawing Sheets



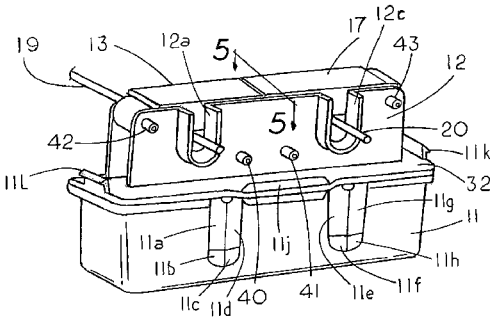


FIG. 1

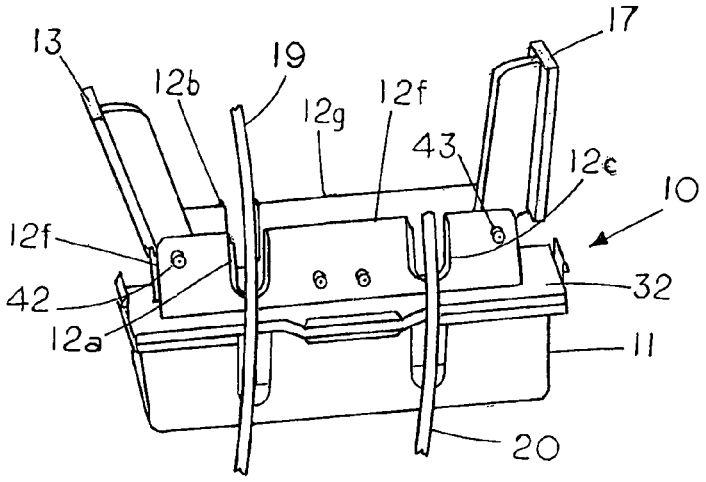


FIG. 2

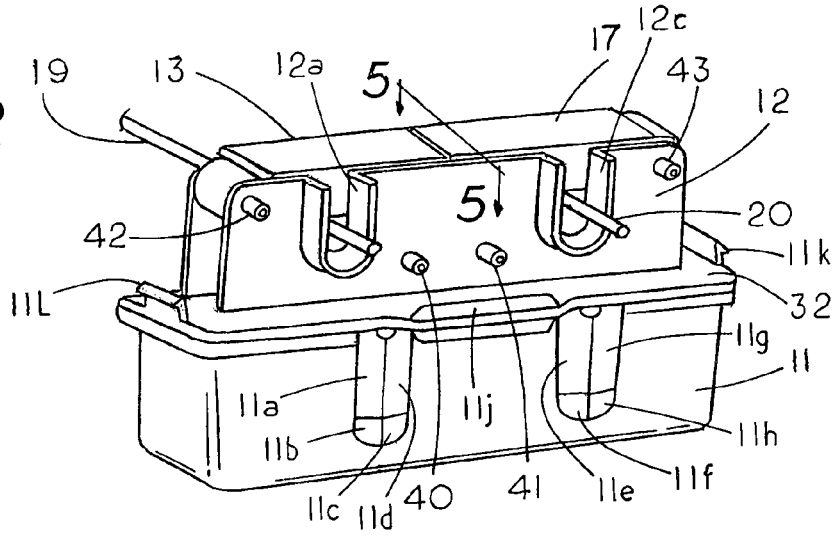


FIG. 2A

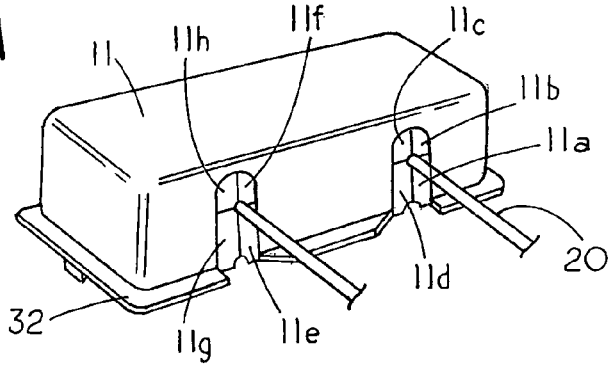


FIG. 3

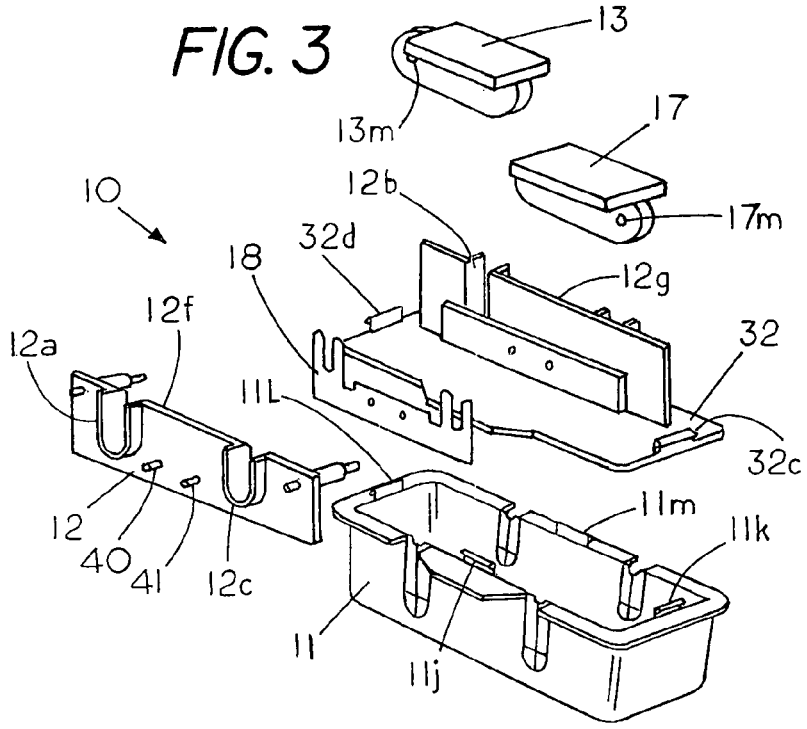
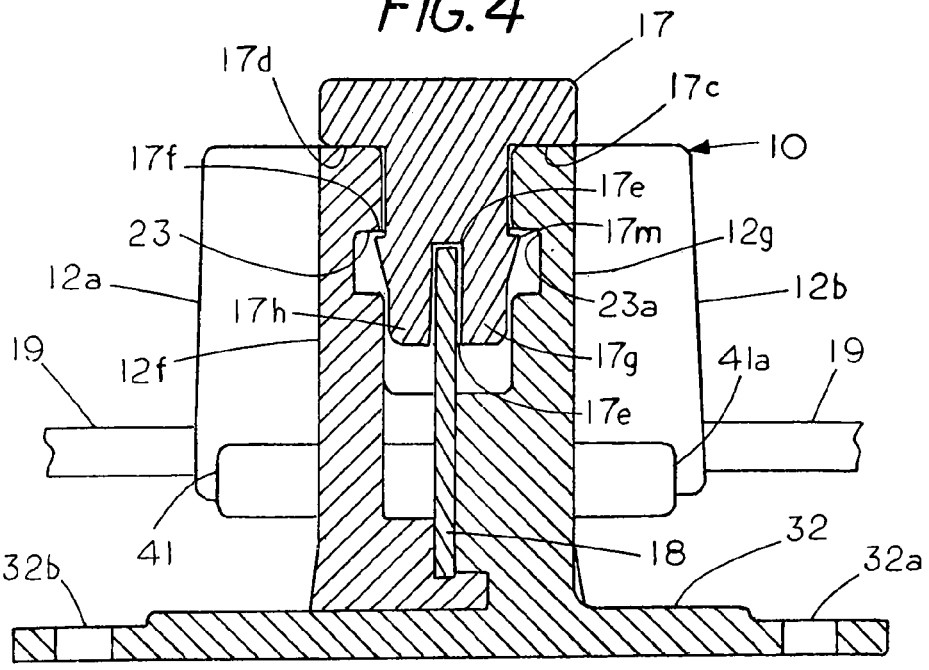

13
13m
17
17m
10
12b
32d
18
12g
12f
32
12a
11L
32c
11m
11k
12
40
41
12c
11
11j

FIG. 4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17d
17c
10
17f
17e
23
17m
12g
12a
23a
12b
17h
19
12f
17g
41a
19
17e
41
18
32
32b
32a

FIG. 5

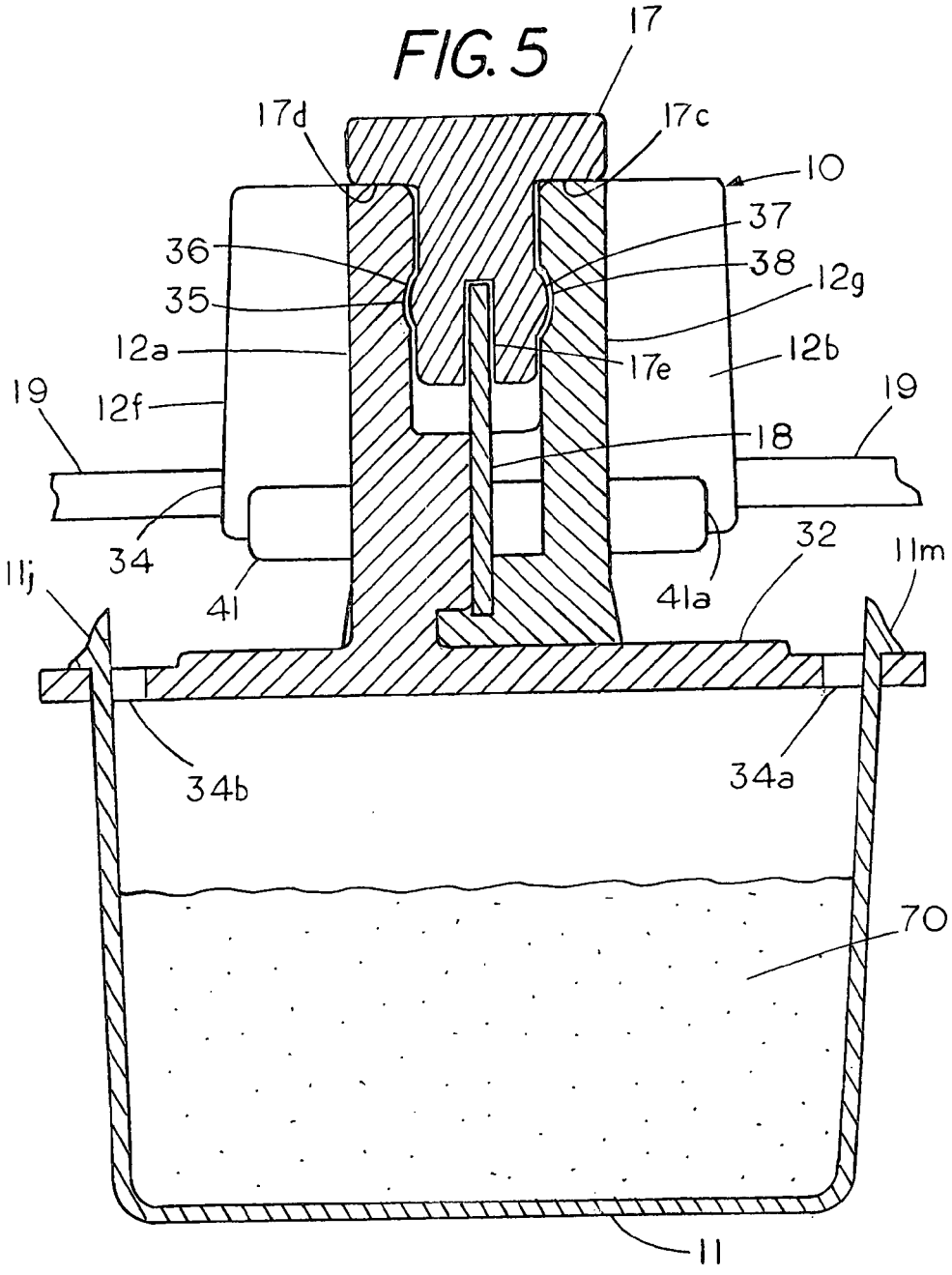

17
17d
17c
10
37
36
38
12g
35
12a
17e
12b
19
12f
19
18
34
32
11m
11j
41
41a
34b
34a
70
11

FIG. 6

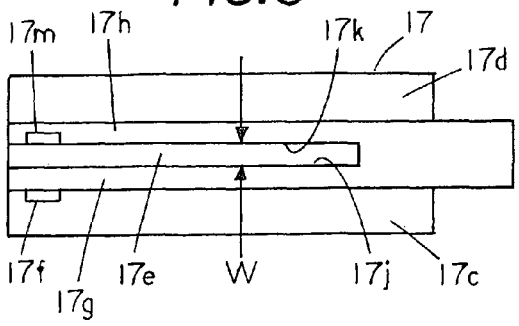


FIG. 7

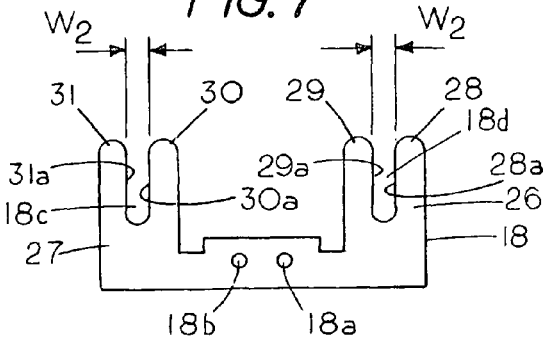


FIG. 7A

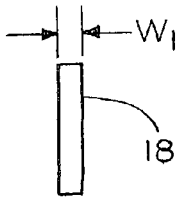


FIG. 8

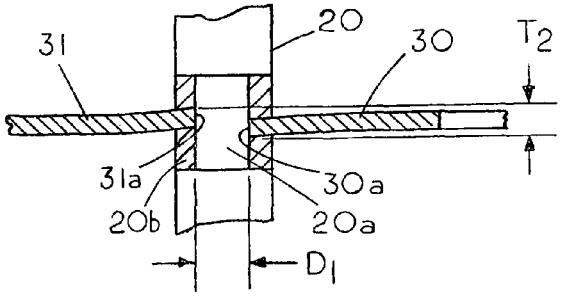


FIG. 9

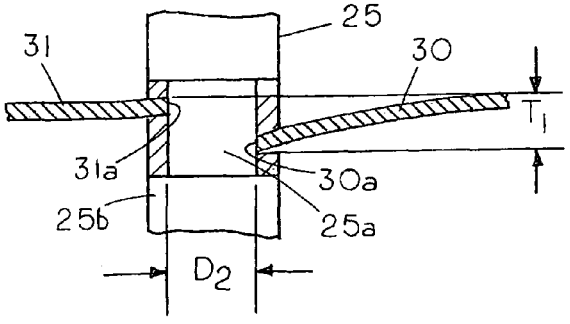


FIG. 9A

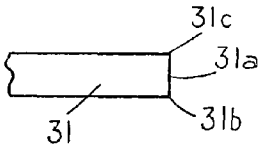


FIG. 10

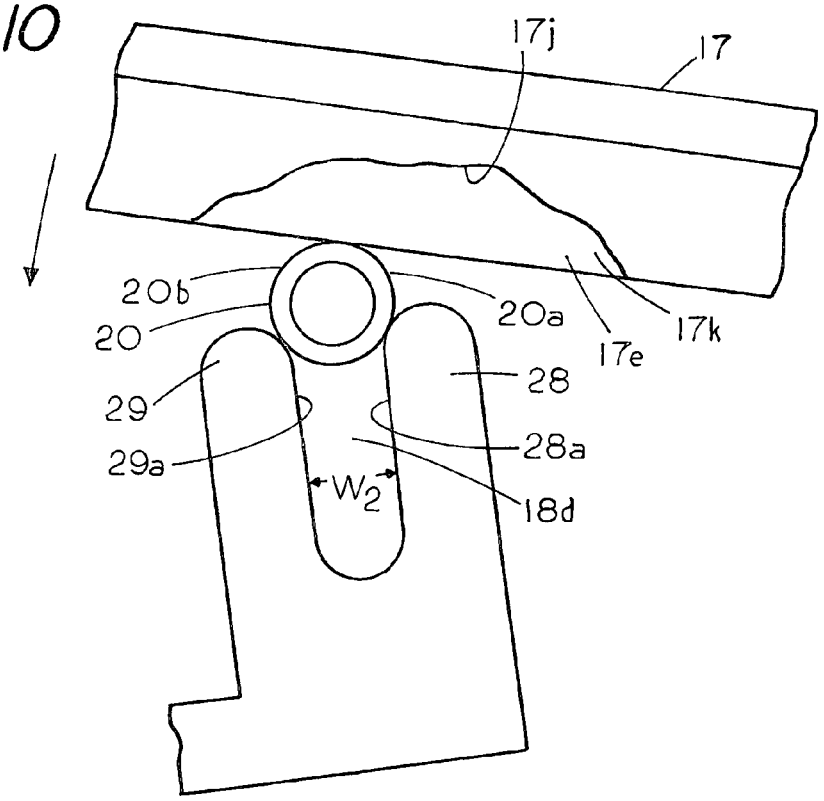
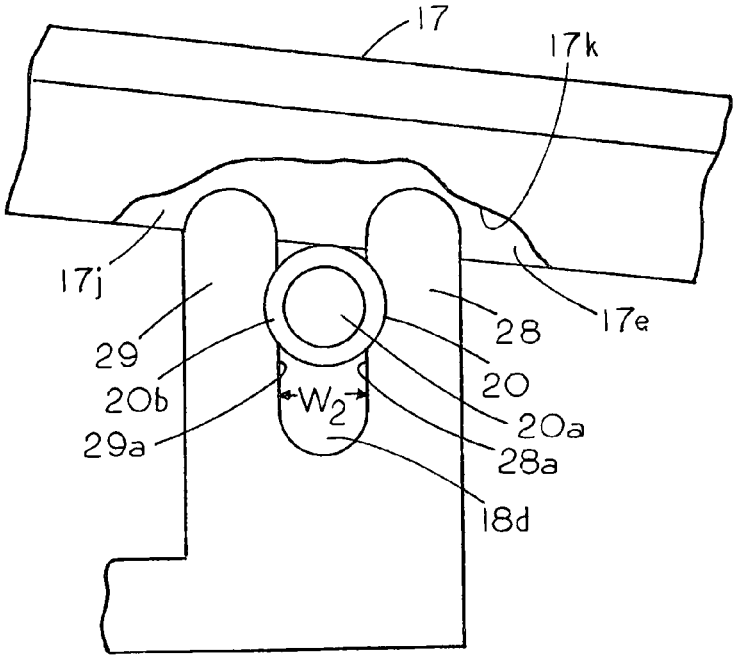

17j
17
20b
20
20a
17e
17k
28
29
28a
29a
W2
18d

FIG. 11


17
17k
17j
17e
28
29
20
20b
20a
W2
28a
29a
18d

INSULATION DISPLACEMENT WIRE CONNECTORS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. provisional application Ser. No. 61/995,181 filed Apr. 4, 2014.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None

REFERENCE TO A MICROFICHE APPENDIX

None

BACKGROUND OF THE INVENTION

This invention relates generally to insulation displacement wire connectors and, more specifically, to wire connectors that allow one person to quickly connect two electrical wires to each other without the aid of tools and without having to cut or remove the insulation from either of the wires.

Although the wire connector may be used in many fields one of the fields that the invention is well suited for use is the tracer wire field since frequently branch wires are formed into electrical connection with a tracer wire. For example, the tracer wire field periodically requires one to form electrical branch connections to the tracer wire without cutting the tracer wire, which may follow an underground feature such as a pipeline. Examples of various types of tracer wire connectors can be found in U.S. Pat. No. 7,179,114; U.S. Pat. Nos. 8,637,774; 7,950,956; 7,093,858 and 7,179,114. Typically, to connect two wires together may require one hand to hold a set of wires in position for electrical engagement while also supporting one section of a two-part connector and with the other hand align a second section of the two-part connector with the first section of the two-part connector. Next, one engages the parts of the two-part connector to each other to form an electrical connection of the wires therein. Connections that require wire alignment before securement are typically best suited for two people since one person can hold the wires in position while the other person aligns the wires and engages the two parts of the two-part wire connector with each other.

SUMMARY OF THE INVENTION

A user-friendly wire two-stage wire connector for field use and on the go use to enable a person working alone to splice two insulation coated electrical wires to each other without having to remove the wire insulation coating from either of the wires, without the aid of tools and without having to cut the wires. The wire connector including a pair of opposed rotateable pivot arms that can be separately rotated from an open condition to a closed or locked condition as electrical wires with an insulation cover thereon are pushed between resilient tabs on an edge connector to simultaneously bring each of the electrical wires into electrical contact with the edge conductor and each other with a dual mode housing convertible from a wire connector hand grip to a protective cover over joined electrical wires.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a pictorial view of an insulation displacement wire connector in an open condition;

FIG. **2** is a pictorial view of the insulation displacement wire connector of FIG. **1** in a closed or wire connecting condition;

FIG. **2**A is a pictorial view of the insulation wire connector of FIG. **1** in a closed condition;

FIG. **3** is an exploded view of the insulation displacement wire connector of FIG. **1**;

FIG. **4** is a sectional view of the insulation displacement wire connector of FIG. **1** with a**1** taken along lines **5**-**5** of FIG. **2**;

FIG. **5** is a sectional view of an alternate embodiment of an insulation displacement wire connector with an alternate latching mechanism;

FIG. **6** is a bottom view of the pivotal arm of the insulation displacement wire connector of FIG. **3**;

FIG. **7** is an isolated view of the edge connector of the insulation displacement wire connector of FIG. **3**;

FIG. **7**A is an end view of the edge connector of FIG. **7**;

FIG. **8** is an isolated view partially in section of the edge connector of FIG. **7** in engagement with a wire of a first size;

FIG. **9** is an isolated view partially in section of the edge connector of FIG. **7** in engagement with a second larger wire;

FIG. **9**A is an isolated view of the blunt face of the edge connector of FIG. **7**;

FIG. **10** is a partial sectional view of a wire in a position to form an electrical connection therewith; and

FIG. **11** is a partial sectional view of a wire in electrical engagement with lateral side tabs of an edge connector.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** shows a two-stage hand held and hand operable insulation displacement wire connector **10** in an open position with the wire connector **10** carrying a dual mode housing **11** that is a cover in one mode and a hand handgrip in another mode. In the handgrip mode the housing **11** forms a handle for grasping and holding the wire connector **10** during a wire connection stage and in the cover mode the housing **11** covers the electrical connections in the wire connector. The housing **11** is removable from a stored condition as a handgrip on the bottom of wire connector base **32** after completion of electrical connections between two separate electrical wires. Once removed the housing **11** is attachable to the top of the wire connector base **32** as a protective cover for the joined electrical wires in the wire connector.

A feature of wire connector **10** is that no tools are required in forming electrical connections therein making it useful for a field technician to quickly join electrical wires to each other. A further feature is that one person can quickly and easily connect two wires together.

The dual mode housing **11** when used in the cover mode may contain a sealant **70** (FIG. **5**) and can used to encapsulate and protect electrical junctions within the wire connector **10** after the formation of the electrical junctions in the wire connector. In the first stage one forms an electrical connection of insulation covered wire **19** to an internal conductor comprising a wire-engaging member **18** (FIG. **7**) without cutting the wire **19** and without removing the insulation on the insulation covered wire **19**. In the second stage one forms a second electrical connection to the same

internal conductor **18** but at a different location on the internal conductor **18** also without removing the insulation covering on the wire **20**, which allows a work person in the field and on-the-go to conveniently splice wire **20** to wire **19** since all the wire connector components, which are shown in FIG. **1**, are held together as a unit during the two stage connection phase. Once the internal electrical connections are formed one can remove the dual mode housing **11**, which is in the handgrip mode, from base **32** and encapsulate the electrical connector as shown in FIG. **2**A as well as encapsulate the electrical junctions formed therein using only the parts in hand. In some cases a sealant **70** (FIG. **5**) may be located in housing **11** thus enabling the waterproofing of the electrical connections by forcing the sealant around the wire connector as the dual mode housing **11** in the cover mode is attached to the top of the base **32**.

The insulation displacement wire connector **10** includes an elongated base **32** with an elongated protective dual mode housing **11** temporarily and removeably stored on the underside of base **32** through a set of latches. Housing **11** is hand removable from the underside of base **32** and hand attachable to a top side of base **32** for on-the-go formation of an enclosure or cover to protect electrical connections formed to wire **19** and wire **20**. That is, housing **11** includes latch hooks **11***j*, **11***k*, **11**L and **11***m* for attachment to a first or underside of the base **32** when electrical connections are formed with the wire engaging member **18** with the housing **11** removable from the first side of the base **32** and attachable to an opposite side of the base **32** for encapsulation of the wire-engaging member **18** after an electrical connection has been formed therein with the housing side flaps **11***f*, **11***g*, **11***h*, **11***e*, **11***a*, **11***b*, **11***c* and **11***d* flexing to permit the first wire **19** and the second wire **20** to enter there between as the housing **11** is attached to the top side of the base **31** as shown in FIG. **2**A.

In the example shown in FIG. **1** a first tee shaped wire pusher or pivot arm **17** is pivotally mounted on one end of base **32** and a second tee shaped wire pusher or pivot arm **13** is pivotally mounted on the other end of base **32** with operation of each pivot arm independent of the other. A first upright sidewall **12***f*, which is supported by base **32**, is located on one side of arm **13** and arm **17** and a second upright sidewall **12***g*, which is also supported by base **32**, is located on the opposite side of arm **13** and arm **17** with the side walls **12***f* and **12***g* supporting and shielding the wire pushers or pivot arms **17** and **13** when in a closed condition.

A first pivot pin **42** forms a first fulcrum that extends between the upright sidewall **12***g* and upright sidewall **12***f* and through an opening **13***m* (FIG. **3**) in the end of pivot arm **13** to rotationally support pivot arm **13** thereon. A second pivot pin **43** forms a second fulcrum that extends between the upright sidewalls **12***g* and **12***f* and through an opening **17***m* (FIG. **3**) in the end of pivot arm **13** to rotationally support pivot arm **17** thereon. Thus, a set of electrically insulating upright sidewalls **12***f* and **12***g*, which are spaced from each other, support a pair of spaced apart pivot arm fulcrums for pivotally and independently supporting pivot arms **13** and **17** as well as shielding connections and components between the sidewalls **12***f* and **12***g*. Examples of electrically insulating materials suitable for use in connector **10** are acrylonitrile butadiene styrene and polypropylene although other materials may be used without departing from the spirit and scope of the invention.

Wire connector **10** includes a first U-shaped top open wire cradle **12***a* on upright side **12***f* and a second U-shaped top open wire cradle **12***b* in upright side **12***g* that cradle and supports wire **19** which extends through the sides of the wire connector. On the opposite side of connector **10** a U-shaped top open wire cradle **12***c* cradles and supports wire **20** while upright sidewall **12***g* provides an end stop for the end of wire **20**. Thus, during the field formation of an electrical connection between wires **19** and **20** the wire cradles **12***a*, **12***b* and **12***c* hold the wires in a position to facilitate electrical connection of the wires **19** and **20** to each other through an internal edge conductor **18**, which is shown in isolated view in FIG. **7**.

In the example shown in FIG. **1** the end of wire **20** is about to be connected or spliced to wire **19**, which is uncut and extends through the sidewalls **12***g* and **12***f* of wire connector **10**, however, it is envisioned that in some cases one may wish to connect two side by side wires to each other, both of which are uncut. In such a wire connector a further wire cradle may be formed in upright side **12***g*. Each of the wire cradles **12***c*, **12***a* and **12***b* provide support for a wire placed therein to limit downward penetration of the wires into the wire connector **10** as well as limit lateral motion of a wire therein prior to the wire brought into an electrical connection with internal edge conductor **18**.

FIG. **2** shows the two-stage insulation displacement connector **10** in a closed condition after formation of an electrical connection between electrical wire **19**, which is supported in wire cradle **12***a* that is located in upright sidewall **12***f*, and a wire cradle **12***b*, which is located in upright side **12***g* (FIG. **1**). An electrical wire **20**, which is supported in wire cradle **12***c* is located in upright side **12***f*. The wire cradles allow one to quickly and properly position the wires **19** and **20** for forming an electrical connection as well as to hold the wires during and after the formation of an electrical connection between the two wires. A feature of the insulation displacement wire connector **10** is that wire **20** can be electrically connected to wire **19** without having to cut wire **19** or remove the insulation from either wire **19** or wire **20** through edge connector **18** (FIG. **3**) that is located between upright side **12***f* and upright side **12***g*.

Housing **11**, which is temporarily stored on the underside of base **32**, includes a set of wire entry side flaps that permit the housing **11** to be placed around wires that are joined in base **32**. That is, one side of housing includes wire entry side flaps **11***a*, **11***b*, **11***c* and **11***d*, which are each joined to housing **11** by an integral living hinge. Similarly, side flaps **11***e*, **11***f*, **11***h* and **11***g* are each joined to base **11** through an integral living hinge. A third set of identical side flaps are located on the opposite side of housing **11** to accommodate wire **19**. The side flaps permit the housing **11** to extend around the wires as the housing/is placed on the topside of base **32** as a cover since the flaps flex on their living hinges to accommodate the wires **19** and **20**, which are supported in connector **10** by base **32**.

The housing **11** includes latch hooks **11***j*, **11***k*, **11**L, **11***m* (FIG. **3**) for attachment to a first side of the base **32** when electrical connections are formed with the wire engaging member with the housing **11** removable from the first side of the base and attachable to an opposite side of the base **32** for encapsulation of the wire-engaging member **18** after an electrical connection has been formed therein with the housing **11** including flexible side flaps that flex around the first wire and the second wire as the housing **11** is attached to a second side of the base to form a cover around the electrical wires extending through the housing **11**.

FIG. **3** shows an exploded view of the components of the insulation displacement connector **10** revealing a wire-engaging member **18** comprising an electrically conductive edge connector **18**, which can be supported between upright sidewall **12***f* and upright sidewall **12***g* by pins **40** and **41**. In

this example the entire wire connector **10**, with the exception of the edge connector **18**, can be assembled from non-conductive electrical components through a set of pins **40** and **41** that extend through the electrically conductive edge connector **18**.

FIG. **4** is a cross sectional view taken along lines **5-5** of FIG. **2** revealing pivot arm **17** in a closed condition and having a first side lip **17***d* that rests on top of upright side **12***f* and a second side lip **17***c* that rests on top of upright side **12***g*. That is, upright side **12***f* and upright side **12***g* form a stop to limit rotating of pivot arm **17** and hence the penetration of the wire into the wire engaging member thus avoiding damaging the wire by limiting how far a wire can be forced into the wire engaging member **18**. FIG. **4** also shows an end view of a slot **17***e* and FIG. **6** shows a bottom view of pivot arm **17** revealing the slot **17***e* of width W with slot **17***e* formed by web **17***h* and web **17***g* that extend partially along the underside of pivot arm **17**. In this example a latch **17***m* on one side of pivot arm **17** and a latch **17***f* on the opposite side of pivot arm **17** provide for locking engagement of the pivot arm **17** with the upright sides **12***f* and **12***g* to thereby hold the pivot arm **17** in a locked or closed condition once the electrical connection has been formed between the wire edge connector **18** and the wires **19** and **20**. This ensures that the electrical connection can be maintained. As can be seen in FIG. **4** the slotted pivot arm **17** sandwiches the flexible electrical conductor **18** therein as the slotted pivot arm **17** pushes the electrical wires into electrical contact with the electrical connector **18** to limit lateral displacement of the wire connector **18**. Although not shown the pivoting of slotted pivot arm **13** also sandwiches the electrical connector **18** therein as the slotted pivot arm **13** also pushes the electrical wires into electrical contact with the electrical connector **18**.

FIG. **6** and FIG. **7**A show the width W of slot **17***e* as wider than the width W_1 of the edge connector **18** so that the edge connector **18** can be quickly aligned with the slot therein. The width W of slot in relation to the width W_1 of the edge conductor (FIG. **7**A) is such that the slot sidewalls **17***k* and **17***j* allow free passage of edge connector **18** therein but inhibit the edge conductor **18** from bending as the sidewalls engage the wires being forced into tabs extending upward from the edge connector **18**. In addition the pivot arm **17** facilitates alignment of the edge connector **18** with the slot **17***e* since the pivot arm rotates in a plane that extends through the edge connector **18**. The pivot arm **13**, which is located on the opposite end of housing **32**, is identical and is not described herein. In the example shown two pivot arms are described, however, if desired a single pivot arm that can pushingly engage both of the electrical wires may be used to form an electrical connection of the wire engaging member **18** to the electrical wires located in the wire engaging member, however, two pivot arms are preferred since it is generally easier to make one connection at a time than two at once.

FIG. **4** reveals the engagement of a side hook or a side latch **17***f* on pivot arm **17** with a channel wall **23** in upright side **12***f* and the engagement of a side hook or side latch **17***m* on pivot arm **17** with a channel wall **23***a* on upright side **12***g*. In this example the resiliency of the electrical insulation material of pivot arm **17** and upright sides **12***f* and **12***g* allow a tapered face on each of the latches **17***f* and **17***m* to be forced between upright sides **12***f* and **12***g* until the latches are in locking engagement with the channel wall **23** and channel wall **23***a*, which retards or prevents withdrawal as an underside of hook **17***f* and an underside of hook **17***g* engage the respective channel wall **23***a* and **23**. Consequently, once the electrical connection of the wire to connector **18** is formed one is assured that the wire will remain in contact with the wire connector **18**.

As can be seen in FIG. **4** the edge connector slot **17***e* has a width wider that is wider than the width of the edge connector **18** to enable the edge connector **18** to easily fit into slot **17***e*. The purpose of pivot arm **17** is to smoothly and evenly force wire **20** down into the wire engaging edges **28***a* and **29***a* (FIG. **7**) of edge connector **18** as the slot **17***e* extends on both sides of edge connector **19** to confine laterally movement of the edge connector.

FIG. **10** is a partial view that shows that the continued pivoting of pivot arm **17** forces the insulation covered wire **20** into the gap **18***d* in edge connector **18** as blunt edges **28***a* and **29***a* of the edge connector **18** are brought into sliding and insulation piercing engagement with the insulation covered wire **20** while FIG. **11** shows that the continuing pivoting of arm **17** forces wire **20** between tabs **28** and **29** in a continued sliding and insulation piercing engagement to locally remove the flexible wire insulation cover **20***b* while simultaneously forming electrical contact between the tabs **28** and **29** of edge connector **18** and the wire **20**. Once the pivot arm **17** is engaged the latch **17***f* and latch **17***g* (FIG. **4**) the wire **20** is held in position to prevent accidental rotation or release of pivot arm **17** thereby ensuring that the wire **20** held in edge connector **18** remains in position to maintain the wire **20** in electrical contact with the edge connector **18**. Although not shown the pivot arm **13** operates in an identical manner as wire **19** is formed into electrical contact with edge of tab **30** and edge of tab **31**, which are on the opposite end of the edge connector **18**.

Thus, the invention provides a method of independently forming an electrical connection between two wires **19** and **20** without removing the electrical insulation from either and without having to cut the two wires by forcing a first electrical conducting wire **19** between a first set of tabs **30**, **31** (FIG. **7**) on an edge connector **18** wherein the first set of tabs form an interference fit with the first electrical conducting wire **19** to establish an electrical connection to the edge connector **18** and forcing a second electrical conducting wire **20** between a second set of tabs **28**, **29** (FIG. **7**) on the edge connector **18** wherein the second set of tabs form an interference fit with the second electrical conducting wire **20** to establish an electrical connection between the first electrical wire **19** and the second electrical conducting wire **20** through the edge connector **18**.

FIG. **7** shows an isolated front view of a one-piece edge connector **18** for establishing electrical contact with covered electrical wires through penetration of the layer of insulation on the exterior of an electrical wire while FIG. **7**A shows an isolated end view of edge connector **18**. Typically, edge connector **18** may be made from a thin strip of copper alloy, which in addition to having good electrically conductivity also provides both stiffness and resiliency to support cantilevered tabs formed in the edge connector **18**. However, other materials may be used without departing from the spirit and scope of the invention.

In the example shown the edge connector **18** includes a first cantilevered wire-engaging member **27** having a first cantilevered tab **31** and a second cantilevered tab **30** with a wire-receiving slot **18***c* of width W_2 formed by a first edge **31***a* and a second edge **30***a*, which are spaced from each other in a face to face relationship, with each of the tabs having a rounded end surface that converges to a wire receiving slot **18***c* between the tabs. Edge connector **18** also includes a second cantilevered wire-engaging member **26** having a first cantilevered tab **29** and a second cantilevered

tab **28** with a wire-receiving slot **18***d* of width W_2 formed by a first edge **29***a* and a second edge **28***a*, which are spaced from each other in a face to face relationship, with each of the tabs **29**, **28** having a rounded end surface that converges to a wire receiving slot **18***d* between the tabs.

A set of holes **18***a* and **18***b* permit the edge connector **18** to be mounted in base **32** by clamping the edge connector between upright member **12***f* and **12***g* through fasteners **40** and **41**. (FIG. **1**)

FIG. **9**A shows an isolated partial top view of tab **31** of a portion of the edge connector **18** revealing a blunt edge **31***a* and an angled corner **31***b* and an angled corner **31***c*. In operation the blunt edge **31***a* can remove insulation and form an electrical face-to-face connection to a wire as it is forced between the tabs. The blunt edge has the benefit of lessening the chances of cutting the wire that may occur if the edge has a v shaped blade, however, in some applications where harm to the wire would be minimal one may use a v-shaped blade. The other edges are identical and are not described herein.

A feature of the invention is that the wire connector **10** can receive and form electrical connections to a range of different size wires. For example, wire gauges 12AWG and 14AWG may be formed into electrical engagement with slot widths W_2 of the same size. In the event the wire is oversized the flexibility of edge connector **18** accommodates the oversized wire through a deflection of the tabs as shown in FIG. **9**, which causes the rigid angled corners of blunt edge **31***a* to bite into the electrical wire core **25***a*. Thus, with edge connector **18** either the face **31***a* or the angled corners **31***c* or **31***b* or both of the cantilevered tab **31** engage one side of the wire and the corresponding face and angled corners of tab **30** similarly can engage the opposite side to form an electrical connection. The wire connector **10** being able to connect electrical wires of different diameters without changing the spacing between tabs since the flexing of the tabs of the edge connector **18** are used to form electrical connections when the wires are of different sizes.

FIG. **10** shows that in operation of connector **10** a wire **20** is first placed between the rounded top of tabs **29** and **28**. Next, one pivots pivot arm **17** to force the wire downward into the slot **18***d* between the tabs **29** and **28** where the edges **29***a* and **28***a* pierce the insulation to make contact with the electrical wire **20***a* therein. Similarly, a second wire **19** is first placed between the top of tabs **31** and **30** and one pivots pivot arm **13** to force the wire **19** downward into the slot **18***c* between the tabs **30** and **31** where the rigid blunt wire engaging edge **30***a* and the rigid blunt wire engaging edge **31***a* pierce the insulation to make contact with the electrical wire therein. Thus, a first pivot arm **17** forces a first wire **20** into electrical contact with the blunt edges **28***a* and **29***a* of the first set of tabs **28** and **29** and similarly a second pivot arm **13** forces a second wire **19** into electrical contact with the blunt edges of the second set of rigid wire engaging edges **30***a* and **31***a* on tabs **30** and **31** whereby the electrical contact of the first wire with the first set of tabs and the electrical contact of the second wire with the second set of tabs forms an electrical path between the first wire and the second wire through the edge connector **18**.

The width W_2 between tabs **30** and **31** as well as the width W_2 between tabs **28** and **29** is an interference fit with the electrically conducting core of each of the wires inserted therein. The interference fit of tabs **30** and **31** causes the rigid edges **30***a* and **31***a* to penetrate through the insulation covering on the wire therebetween as the wire connector edges **30***a* and **31** are brought into electrical contact with the electrically conducting wire core of the wire. Similarly, the interference fit of tabs **29** and **28** with a wire core therebetween causes the wire connector edges **30***a* and **31***a* to penetrate through the insulation covering **20***b* on the wire **20** as the rigid edges **29***a* and **28***a* are brought into electrical contact with the electrically conducting wire core of the wire.

To appreciate edge **30***a* and edge **31** engagement with an electrically conductive wire core reference should be made to FIG. **8**, which shows wire **20** having an electrically conducting core **20***a* and a soft flexible outer insulation cover **20***b*. In the example shown wire **20** has been forced between tabs **31** and **30** causing the wire edges **30***a* and **31***a* to penetrate the insulation covering **20***b* to make electrical contact with the electrical conductive wire core **20***a*. Similarly, wire **19** can be formed into electrical contact with tabs **28** and **29** through engagement of edges **28***a* and **29***a*, which engage the electrical wire core therein.

FIG. **10** and FIG. **11** are isolated views showing the formation of an electrical connection with wire **20**, which has an eclectically conducting core **20***a* and a soft, flexible, annular, outer insulation covering **20***b*. FIG. **10** shows the wire **20** supported on the rounded ends of tabs **28** and **29** since the diameter of the wire **20** is greater than the slot width W_2. The pivot arm **17** with slot **17***e* is shown partially in section and in position to push or force the wire **20** between the tabs **28** and **29**. In this example the rounded ends act as a funnel or guide to direct the wire **20** into the slot **18***d* between tabs **28** and **29** as the pivot arm **17** is rotated. As the wire **20** is forced between the tabs **28** and **29** the blunt edges **28***a* and **29***a* penetrate the soft, flexible, outer insulation cover **20***b* until the blunt edges **28***a* and **29***a* engage the wire connector **20***a* because of an interference fit between the gap W_2 of the tabs **28** and **29** and the diameter of core **20***a*. The interference fit causes the tabs to yield slightly along a plane extending through the tabs as the wire is forced between the tabs. The spreading of the tabs along a plane through the tabs creates a compressive force on the wire to maintain the edges of the tabs in electrical contact with the wire **20**. However, if the interference is to great tabs may be spread beyond a yield point and thus may not maintain itself in electrical contact with the wire. A feature of the invention is that a portion of a spreading force can be used to laterally deflect the tabs without exceeding the yield point of the material and thus allow more than one size wire to be connected in the wire connector. Thus a feature of the invention is the wire-engaging member **18** comprises a rigid but laterally resilient member that enables on-the-go connection to a pair of electrical wires as illustrated in FIGS. **8-11**.

FIG. **11** shows the pivot arm **17** after the pivot arm has been rotated sufficiently to force wire **20** into the slot **18***d* between tabs **28** and **29**. In this condition the edges **28***a* and **29***a* have pierced the insulation covering **20** and are in contact or electrical engagement with the electrical conducting core **20***a*. In addition the end of tab **28** and the end of tab **29** are located within slot **17***e* and are laterally confined by the sidewall **17***j* and sidewall **17***k* to prevent the tabs **28** or **29** from folding over if the diameter of the wire is sufficiently larger than the width W_2 between the wires. Similarly, pivot arm **13** includes identical sidewalls to prevent the tabs **30** or **31** from folding over if the diameter of the wire is sufficiently larger than the width W_2 between the wires,

A feature of the wire connector **10** is that the edge connector **18** can form electrical connections with wires of different sizes through a flexing action of the tabs of the edge connector **18**. To illustrate this feature FIG. **8** shows a sectional view at the points of contact of a wire **20** with the tabs **30** and **31** and FIG. **9** shows a sectional view of the points of contact of a larger wire **25** with the tabs **30** and **31**.

FIG. **9** shows wire **25** having an electrical conductive core **25***a* and a soft flexible outer insulation cover **25***b* with the wire edge **31***a* in engagement with one side of wire **25** and wire edge **30***a* in engagement with the opposite side of wire **25**. The distance between the tabs in the unengaged condition is W_2 as shown in FIG. **7**, however, in the engaged condition shown in FIG. **9** the wire edges **31***a* and **30***a* have been forced apart axially and laterally to accommodate the larger diameter D_2 of wire **25** through a lateral flexing of the tabs **30** and **31**, which is revealed by the distance T_1 that indicates the flexing of the tabs at the points of contact of the tabs in response to the wire **25** being forced therebetween. In contrast, as shown in FIG. **8** the smaller wire **20** which is in engagement with the tabs **30** and **31** produces less flexing of the tabs as indicate by the dimension T_2, which is less than the dimension T_1. However, in both cases an electrical connection to the tabs **30** and **31** has been formed. With the larger wire **25** the confinement of the side walls of **17***k* and **17***j* of the pivot arm with the cantilever ends of tabs **29** and **30** can maintain the tabs **29** and **30** in position to penetrate the insulation and make electrical contact with the wire core **25***a* even though the tabs may flex at the point of contact with the electrical wire. Thus, a feature of the invention is that the wire connector **10** can accommodate a range of wire sizes through the resiliency of flexible tabs **29** and **30**, which can redirect a portion of a tab spreading force to laterally deflect the tabs in response to the larger diameter wire in engagement with the wire core. For example, with copper alloy tabs having a thickness W_1 of 0.032 inches and a width W_2 one can connect a wire **20** such as shown in FIG. **8** that forms an interference fit 0.008 inches between the wire and the edges of the edge connector or one can connect a wire **25** that forms an interference fit of 0.025 inches between the wire and the edges of the edge connector. In either case one can obtain a good electrical connection. The example provided herein is to illustrate the ability of the tabs of the same width to electrically engage wires of different size although no limitation to dimensions or materials is intended. The feature of the laterally deflection of the tabs as well as the spreading of the tabs allows the spreadable tabs to form an interference fit with different size wires while at the same time the material of the tabs is not stressed beyond the yield point of the material.

Once the wire edge connector **18** engages the wire the pivot arm **17** is latched to maintain the pivot arm and hence the wire in position against the edge connector. A reference to FIG. **4** shows a latch comprising hooks **17***f* and **17***m* while a reference to FIG. **5** shows a latch on arm **17** formed by a dimple **35** in upright **12***a* and protrusion **36** on one side of lever **17** and a dimple **38** in upright **12***g* and a protrusion **37** on one side of lever arm **17**. In the latched position as shown in FIG. **5** the lever arm is maintained in position thereby ensuring that the wire located in the edge connector **18** is maintained in the edge connector **18**. In this example the ledge **17***c* of pivot arm **17** engages the top of upright **12***g* and ledge **17***d* engage the top of upright **12***a* as the dimples and protrusions secure the pivot arm in position while in the example of FIG. **4** the hook **17***f* engages the channel wall **23** and the hook **17***m* engages the channel wall **23***a* to hold the pivot arm in position.

FIG. **5** shows the hand attachable housing **11** in section with end fasteners for latching the housing **11** to either the top or the bottom of base **32**. Housing **11** includes a cantilevered latch hook **11***j* having a tapered face on one side and a cantilevered latch hook **11***m* having a tapered face on the opposite side with hook **11***j* extending through opening **34***b* to engage base **32** and hook **11***m* extending through hook **34***a* to engage base **32** to removable store the housing **11** as a handgrip on the underside of base **32** as wires are being connected to each other through the wire engaging member **10**. By squeezing the sides of housing **11** the fastener comprising latch hook **11***j* and the fastener comprising latch hook **11**L can be forced inward toward each other from housing **11** allowing one to remove housing **11** from the underside of base **32**. Once removed the housing **11** which can function either as a cover or handgrip can be reversed and placed on the top of wire connector **10** with the latches **11***j* and **11***m* of the housing **11** engaging the base **32** from the top side to thereby form a protective cover over the wire connector **10**. That is, by engaging latch hook **11***j* and latch hooks **11***m* from the topside of base **32** rather than the underside of the base one can form a protective cover over the electrical connections therein.

FIG. **3** illustrates that the ends of housing **11** may include latch **11**L and **11***k* that fastened in an identical manner to latch **11***j* and latch **11***m*. Thus, the fasteners or latches comprising hooks **11***k* and **11**L on the end of housing **11** (FIG. **3**) can similarly be engaged with openings **32***d* and **32***c* in base **32** from either the top side of base **32** or the bottom side of base **32**.

We claim:

1. A wire connector comprising:

an elongated base;

an electrically conductive wire-engaging member extending along the elongated base with the wire-engaging member having a first set of resilient wire engagement tabs cantilevered therefrom with a first wire receiving slot therebetween and a second set of resilient wire engagement tabs cantilevered therefrom with a second wire receiving slot therebetween with each of the wire engagement tabs flexing in response to insertion of an insulation covered wire therebetween;

a first wire cradle for holding a first insulation covered wire in position for sliding into insulation piercing engagement with the first set of resilient wire engaging tabs;

a second wire cradle for holding a second insulation covered wire in position for sliding into insulation piercing engagement with the second set of resilient wire engaging tabs;

a first edge and a second edge on said first set of wire engagement tabs;

a first edge and a second edge on said second set of wire engagement tabs;

a first pivot arm pivotally mounted on one end of said base, said first pivot arm having a slot aligned with said first set of tabs for receiving the first set of wire engaging tabs as the first pivot arm pivots and forces a first wire into electrical contact with the first edge and the second edge of the first set of tabs as the tabs extend into the slot of the first pivot arm;

a second pivot arm spaced from said first pivot arm and in axial alignment with said first pivot arm, said second pivot arm having a slot aligned with said second set of tabs as the second pivot arm pivots and forces a second wire into electrical contact with the first edge and the second edge of the second set of wire engagement tabs, said second set of tabs extending into the slot in the second pivot arm, the electrical contact of the first wire with the first set of wire engagement tabs and the second wire with the second set of wire engagement tabs forming an electrical path between the first wire and the second wire as the first edge and the second

edge of the first set of wire engagement tabs flex to bring the first insulation covered wire into contact therewith and the first edge and the second edge of the second set of wire engagement tabs flex to bring the second insulation covered wire into contact therewith; and

a dual mode housing providing a handgrip when attached to a first side of the base and a cover when attached to the opposite side of the base.

2. The wire connector of claim **1** wherein the first edge and the second edge on the first set of tabs engages opposite sides of the first wire and the first edge and the second edge on the second wire engagement tabs engages opposites sides of the second wire.

3. The wire connector of claim **1** wherein the wire engaging member comprises an edge connector with the first set of tabs cantilevered from the edge connector and the second set of tabs cantilevered from the edge connector wherein the first set of cantilevered tabs are resiliently and laterally deformable to accommodate the first electrical wire and the second set of cantilevered tabs are resiliently and laterally deformable to accommodate the second electrical wire where the second electrical wire is larger than the first electrical wire.

4. The wire connector of claim **1** including the dual mode housing includes latch hooks for attachment to a first side of the base as a handgrip when electrical connections are formed to the wire engaging member, said housing removable from the first side of the base and attachable to an opposite of the base as a cover for encapsulation of the wire-engaging member after an electrical connection has been formed therein with the housing including side flaps, said side flaps flexing to permit the first wire and the second to enter there between as the cover is attached to a second side of the base.

5. The wire connector of claim **1** wherein the wire connector is a tracer wire connector and the wire connector includes a set of wire cradles for supporting an uncut wire and at least one wire cradle for supporting a wire to be joined to the uncut wire.

6. The wire connector of claim **1** wherein an end of each of the first set of wire engagement tabs is restrained from lateral movement by a pair of sidewalls in the first pivot arm and the end of each of the second set of wire engagement tabs is restrained from lateral movement by a pair of sidewalls in the second pivot arm.

7. The wire connector of claim **1** wherein the first pivot arm includes a latch for securing the first pivot arm to the base.

8. The wire connector of claim **7** wherein the latch comprises a hook for engaging a channel wall supported by said base.

9. The wire connector of claim **7** wherein the latch comprises a protrusion for engaging a first dimple to retard or prevent rotation of the first pivot arm.

10. A wire connector for forming an electrical path between two wires of equal or different size comprising:

an electrically conductive wire engaging member;

a member for forcing a first insulation covered wire into the first set of rigid wire engaging edges;

a further member for forcing a second insulation covered wire into the second set of rigid wire engaging edges;

a base supporting said electrically conductive wire engaging member with said electrically conductive wire engaging member including a first laterally flexible tab having a first rigid wire engaging edge and a second laterally flexible tab having a second rigid wire engaging edge with the first laterally flexible tab and the second laterally flexible tab flexing laterally to accommodate a larger diameter wire by redirecting a portion of a tab spreading force to laterally deflect the first laterally flexible and the second laterally tab wherein a first wire located in the first set of rigid wire engaging edges and a second wire located in the second set of rigid wire engaging edges are in electrically communication with each other through the electrically conductive wire engaging member.

11. The wire connector of claim **10** wherein the wire-engaging member comprises a rigid but laterally resilient member having a pair of blunt edges for piercing an insulation covering on an electrical wire in order to contact an electrical wire core therein.

12. The wire connector of claim **10** including a set of electrically insulating upright members spaced from each other, said upright members forming a pivot arm fulcrum for pivotally a supporting a pivot arm thereon.

13. The wire connector of claim **10** wherein the member comprises a first pivot arm for maintaining the first wire in electrical engagement with the first set of rigid wire engaging edges and the further member comprises a second pivot arm for maintaining the second wire in electrical engagement with the second set of rigid wire engaging edges.

14. The wire connector of claim **13** said housing comprises an electrical insulation material mode housing attachable to either side of the base.

15. A method of forming an electrical connection between two wires without removing the electrical insulation from either and without having to cut the two wires comprising;

forcing a first electrical conducting wire between a first set of tabs on an edge connector with the first set of tabs flexing laterally to accommodate a larger diameter wire by redirecting a portion of a tab spreading force to laterally deflect a first laterally flexible tab and a second laterally tab in the first set of tabs wherein the first set of tabs form an interference fit with the first electrical conducting wire to establish an electrical connection to the edge connector; and

forcing a second electrical conducting wire between a second set of tabs on the edge connector with the second set of tabs flexing laterally to accommodate a larger diameter wire by redirecting a portion of a tab spreading force to laterally deflect a first laterally flexible tab and a second laterally tab in the second set of tabs wherein the second set of tabs form an interference fit with the second electrical conducting wire to establish an electrical connection between the first electrical wire and the second electrical conducting wire while holding the first wire in contact with the first set of tabs and the second wire in contact with the second set of tabs.

16. The method of claim **15** including the step of pivoting a slot in a first pivot arm around the first set of tabs to force the first electrical conducting wire between the first set of tabs and pivoting a slot in the second pivot arm around the second set of tabs to force second electrical conducting wire between the second set of tabs wherein each of the set of tabs has a blunt edge for piercing through an electrically conducting insulation covering.

17. The method of claim **15** including the step of forcing the first electrical conducting wire comprises laterally deflecting the first set of tabs.

18. The method of claim **15** including the step of placing a first electrically conducting wire comprise placing an electrically conducting wire with an insulation covering

thereon and piercing through the insulation with a blunt edge on the first set of tabs and placing a second electrically conducting wire comprise placing an electrically conducting wire with an insulation covering thereon and piercing through the insulation with a blunt edge on the second set of tabs.

19. The method of claim **15** including the step of laterally confining an end of the first set of tabs as the first wires is forced between the first set of tabs.

20. The method of claim **15** including the step of forcing a wire of first diameter between the first set of tabs and a second wire of a larger diameter between the second set of tabs wherein the width of the slot between the first set of tabs and the width of the slot in the second set of tabs is the same.

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